Arkansas Research and Development Plan

A Strategic Plan To Guide Arkansas into the 21st Century

April 1996

Vision and Goals

Economic Growth based on Science and Technology with Improved Science and Technology Education Available to All.

The two primary goals are:

1) to insure that Arkansas achieves national recognition in research and development (R&D); and
2) to enhance the quality of life for Arkansans through increased R&D activity.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In May 1994, Governor Jim Guy Tucker appointed a task force that he charged with developing a research and development (R&D) plan for Arkansas state government. This document describes the resulting plan. It details strategies designed to promote scientific knowledge in the general population and to increase the number of graduates majoring in science, math and engineering. It also provides suggested approaches for improving the R&D climate of the State and identifies six areas in which Arkansas should invest for the future. These areas are:

- Advanced Materials
- Agriculture, Food and Life Sciences
- Biotechnology and Bioengineering
- Environment
- Manufacturing Systems
- Transportation and Logistics

INTRODUCTION

Active Research and Development (R&D) is essential for achieving and maintaining a high standard of living; therefore, it is important for Arkansas state government to have a coherent plan for supporting R&D.

This plan would go beyond the goals of federal funding agencies and research plans of the universities in the state. It would be broader than state agency research missions. A state R&D plan would give guidance to state policy makers facing new investment opportunities in research and development. Having faced such opportunities with scarce financial resources, in May 1994 Governor Jim Guy Tucker convened a task force composed of concerned citizens including representatives of industry, state agencies and federal agencies, and faculty from state institutions of higher education (see Appendix A for a complete list of invited individuals).

This task force was charged with developing a strategic plan for enhancing R&D in Arkansas. The desired plan would emphasize the state's broad R&D needs and complement federal and university research agendas. The task force first met on June 15, 1994, with John W. Ahlen as the chair, and decided to divide into four working groups: Human Resources; Policy/Infrastructure; R&D Capacity; and Communications.

Charles Dunn, President of Henderson State University, representing the Presidents and Chancellors Committee of the Department of Higher Education, was selected as chair of the Human Resources Group. John Shelnutt, from the Arkansas Institute for Economic Advancement at the University of Arkansas at Little Rock, was selected chair of the Policy/Infrastructure Group. Larry Wright, representing the U.S. Army's Pine Bluff Arsenal, was selected chair of the R&D Capacity Group, and Bo Ryall, director of the Science Information Liaison Office, was selected chair of the Communications Group. The membership of each working group is listed in Appendix A.

The Human Resources Group was charged with examining future Arkansas needs in terms of human resources and developing strategies to meet those needs.

The Policy/Infrastructure Group was asked to examine the R&D environment of Arkansas and develop strategies to improve that climate.

The R&D Capacity Group was charged with examining ongoing R&D activities in Arkansas and recommending areas appropriate for future state support.

The Communications Group was charged with developing strategies to promote Arkansas' access to the information superhighway.

The plan that follows was derived from the work of these groups. Summary reports of each working group are available in Appendix C. Also, a brief history of R&D in Arkansas is provided as Appendix B.

ARKANSAS RESEARCH AND DEVELOPMENT PLAN

These actions were recommended by the Task Force as important steps in the development of R&D in Arkansas:

Human resources should be improved by:

1. Strengthening minority participation at all levels of education, including increased recruitment and retention of minority faculty;
2. Developing an increased consciousness of human resources development in all R&D activities;
3. Developing the National Science Foundation's Rural Systemic Initiative Program with Louisiana and Mississippi;
4. Increasing the use of technology in educational programs at all levels (in-service teacher training programs should be implemented to provide educators with a better understanding of science and currently available technology);
5. Increasing research opportunities for high school and undergraduate students, and increasing the investment in graduate student research support;
6. Encouraging collaborative efforts in research and education among all educational and private institutions in Arkansas;
7. Encouraging the recruitment and retention of productive research scientists at all institutions of higher learning in the state; and
8. Increasing science literacy in the state.

The climate for R&D should be improved by:

1. Developing a technology extension service program for Arkansas;
2. Strengthening computer networking within the state;
3. Developing shared instrumentation resources;
4. Developing appropriate focus groups that promote interactions among individuals and institutions involved in the R&D enterprise;
5. Providing financial incentives to promote R&D in the private sector (possible incentives include enterprise zones[*], investment tax credits, loss write-off legislation for R&D[**], sales tax exemptions on R&D, assessment practices for R&D facilities, and other tax exemptions);
6. Providing matching funds for major R&D grants and contracts;
7. Increasing the number of doctoral graduates in science and technology by providing incentives and interdisciplinary programs;

[*] See Act 394 of 1995.
[**] See Act 586 of 1995.

8. Providing incentives to encourage students, especially women and minorities, to go into math, sciences, and engineering (tuition waivers and forgivable loans could be considered);
9. Providing incentives to promote technology-transfer (suggested incentives include liberal university patent policies, a patent/copyright assistance program, and programs designed to encourage university and college faculty to spin-off research ideas into private business and/or manufacturing);
10. Promoting the development of research parks by:
    A. Providing planning assistance to community leadership (perhaps as part of the Arkansas Industrial Development Commission's program Arkansas Community of Excellence);
    B. Assisting in the establishment of partnerships among industry, academic institutions and government labs (for example Arkansas/Marshall Space Flight Center agreement, signed in 1993); and
    C. Identifying low-cost land with adequate utilities and accessibility;
11. Improving the climate for R&D in institutions of higher education by:
    A. Changing the depreciation schedule for research equipment and computers;
    B. Allowing the use of provisional positions as needed for grants and contracts;
    C. Recognizing the different needs of R&D as compared to classroom education; and
    D. Including R&D components as criteria for higher education productivity; and
12. Creating an infrastructure to assist in grant procurement and administration.

The following areas should be given priority in terms of state government support:

- Advanced Materials
- Agriculture, Food and Life Sciences
- Biotechnology and Bioengineering
- Environment
- Manufacturing Systems
- Transportation and Logistics.

In addition to the communications items listed above, Arkansas should:

1. Facilitate communication linkages among businesses, research facilities and university faculties;
2. Encourage collaboration among campuses;
3. Link state and federal resources and opportunities; and
4. Develop a state R&D database that identifies areas of expertise, areas of growth, and areas of interest.

APPENDIX A

INDIVIDUALS INVITED TO PARTICIPATE IN THE R&D PLANNING GROUP AND MEMBERSHIP OF THE FOUR WORKING COMMITTEES

INVITED PARTICIPANTS

Governor Tucker invited the directors of the following entities (or their designees) to participate in the R&D Planning Task Force:

STATE AGENCIES

Commission for Arkansas' Future
Department of Education
Department of Higher Education
Development Finance Authority
Forestry Commission
Game and Fish Commission
Highway and Transportation Department
Industrial Development Commission
Livestock and Poultry Commission
Pollution Control and Ecology Department
Science & Technology Authority
Soil and Water Conservation Commission

ACADEMIA

EPSCoR Committee
Division of Agriculture (UA)
University of Arkansas at Little Rock
Public schools
Presidents and Chancellors (ADHE)
University of Arkansas for Medical Sciences
Private University

FEDERAL AGENCIES

National Center for Toxicological Research
Pine Bluff Arsenal
Biological Survey at Stuttgart
EPA Combustion Facility located on the NCTR campus

PRIVATE COMPANIES

Arkansas Institute
AIDC (as an industry representative)
Metalworking industry
The Arkansas Poultry Foundation
Transportation and trucking industry
Arkansas Biotechnology Association

LEGISLATURE

Senate
House of Representatives

Science Information Liaison Office

WORKING GROUP ASSIGNMENTS

HUMAN RESOURCES	POLICY/ INFRASTRUCTURE	R&D CAPACITY	COMMUNICATIONS
Dunn*	Blakley/Jenkins	Brunton	Ahlen
Fuller	Eldridge	Davis	Henderson
Goodwin	George	Griffin	O'Brien
Graham	Geren	Levins	Ryall*
Julian	Lile	Lindley	
Spraggins	Schwetz/Brand	Kemp	
Sweeney	Shelnutt*	Norris/Britt	
ASU Rep	Tilford/Brummett	Shult	
UAPB Rep	Wilson	Tripp	
		Wright*	

* Chair

R&D Planning Group

Dr. John Ahlen
Arkansas Science & Technology Authority
100 Main Street, #450
Little Rock, AR 72205
324-9006; FAX: 324-9012

Mr. Jim Blakley and/or
Mr. Morris Jenkins
AIDC
#2 Capitol Mall, Room 4C300
Little Rock, AR 72201
682-7377; FAX: 682-7341

Mr. Ellis Brunton
Tyson Foods, Inc.
2210 Oaklawn Drive
Springdale, AR 72764
290-4041; FAX: 290-7973

Mr. Bryan Davis
Chief, Planning and Research
Highway and Transportation Department
PO Box 2261
Little Rock, AR 72203
569-2201; FAX: 569-2400

Dr. Charles Dunn
President
Henderson State University
Box 7532
Arkadelphia, AR 71999-0001
246-5511 ext.3233; FAX: 246-2608

Mr. Danny Fuller
High School Chemistry Teacher
8805 Fairhaven Drive
Little Rock, AR 72205
450-1252; FAX: 450-1200 (summer)

Dr. Collis Geren
EPSCoR Committee
119 Ozark Hall
University of Arkansas
Fayetteville, AR 72701
575-5900; FAX: 575-3846

Dr. Tom Goodwin
Chemistry Department
Hendrix College
Conway, AR 72032
450-1252; FAX: 450-1200

Mr. Bob Graham
Department of Pollution Control and Ecology
8001 National Drive
Little Rock, AR 72209
570-2877; FAX:

Dr. Bill R. Griffin
Research Director
Fish Farming Experimental Lab
National Biological Survey
PO Box 860
Stuttgart, AR 72160
673-4483; FAX: 673-7710

Mr. Scott Henderson
Assistant Director
Game and Fish Commission
#2 Natural Resources Drive
Little Rock, AR 72205
223-6309; FAX: 223-6448

Dr. Diana Julian
Department of Education
4 Capitol Mall
Little Rock, AR 72201-1071
682-4204; FAX: 682-

Mr. Wesley Kemp
Senior Vice President for Operations
ABF Freight Systems, Inc.
301 South Eleventh Street
Fort Smith, AR 72901
785-8770; FAX: 785-8781

Mr. Robert R. Levins
Forestry Commission
3821 West Roosevelt Road
Little Rock, AR 72204
664-2531; FAX:

Ms. Pat Lile
Executive Director
Arkansas Commission for the Future
PO Box 1901
Little Rock, AR 72203-1901
324-9820; FAX: 324-9823

Dr. Barry Lindley
V Chan. for Acad. Affairs/Sponsored Research
Slot 541
Univ. of Ark. for Medical Sciences
4301 West Markham
Little Rock, AR 72205
686-5689; FAX: 686-8137

Dr. Paul Norris and /or
Mr. James Britt
Diagnostic Laboratory
Arkansas Livestock and Poultry Commission
1 Natural Resources Drive
Little Rock, AR 72205
225-5650; FAX: 225-9727

Dr. Timothy J. O'Brien
Arkansas Biotechnology Association
PO Box 251365
Little Rock, AR 72225
686-6696; FAX 686-8501

Mr. Robert "Bo" Ryall
Science Information Liaison Office
Room 09, State Capitol Bldg.
Little Rock, AR 72201
682-1937; FAX: 682-4379

Dr. Bernard Schwetz
Director, and/or
Mr. Dan Brand
National Center for Toxicological Research
3900 NCTR Road
Jefferson, AR 72079
543-7950; FAX: 543-7576

Dr. Milo J. Shult
Vice President for Agriculture
University of Arkansas
University Tower Building, Suite 608
1123 South University Avenue
Little Rock, AR 72204
686-2565; FAX: 686-2507

Dr. John Spraggins
Deputy Director for Academic Affairs
Department of Higher Education
114 East Capitol Ave.
Little Rock, AR 72201-3818
324-9300; FAX: 324-9310

Mr. Jon Sweeney
Deputy Director
Soil and Water Conservation
101 East Capitol
Little Rock, AR 72201
682-3962; FAX: 682-3991

Mr. Vincent Tilford
President, and /or
Ms. Judy Brummett
ADFA
PO Box 8023
Little Rock, AR 72203-8023
682-5902; FAX: 682-5939

Mr. John Tripp
Executive Vice President/COO
Southern Steel & Wire Company
PO Box 6537
Fort Smith, AR 72906
646-1651; FAX: 646-2443

Mr. Larry E. Wright, PE
SMCPB-CD
US. Army Pine Bluff Arsenal
10020 Kayrich Circle
Pine Bluff, AR 71602-9500
540-3884; FAX: 540-3886

Dr. John Shelnutt
Arkansas Institute for Economic Advancement
University of Arkansas at Little Rock
2801 S. University
Little Rock, AR 72204
569-8550; FAX: 569-8538

Representative Lloyd George°
Route, 1 E
Ola, AR 72853

Mr. Richard Huddleston*
The Arkansas Institute
620 West Third, #101
Little Rock, AR 72201
375-4678; FAX: 375-4680

Ms. Kelly Hunt°
Governor's Liaison
State Capitol, Room 205
Little Rock, AR 72201
682-3626; FAX 682-1382

Senator Nick Wilson°
PO Box 525
Pocahontas, AR 72455

Joyce M. Sadler
EPSCoR Program Manager
EPSCoR/ASTA
100 Main Street, Suite 450
Little Rock, AR 72201
324-9006; FAX: 324-9012

* advisory only

APPENDIX B

HISTORY OF R&D IN ARKANSAS

The research history of Arkansas began with the establishment in 1888 of the Agricultural Experiment Station at the University of Arkansas (U of A). The mission of this center was to deal with problems of practical importance to farmers, stock raisers and fruit growers of the state. Basically, the research was designed to bolster the production of existing crops. The mission of the Experiment Station has changed since 1888 and will continue to evolve. Today's agricultural research is very much "science based" with emphasis on cellular and molecular techniques.

The U of A also has changed with time. By the 1950s, doctoral degrees were being awarded in several fields, and by 1970, the U of A had developed into the five-campus University of Arkansas System, which includes: (1) the original land grant site at Fayetteville as the University of Arkansas, Fayetteville; (2) the University of Arkansas for Medical Sciences (located in Little Rock); (3) the University of Arkansas at Little Rock; (4) the University of Arkansas at Pine Bluff; and (5) the University of Arkansas at Monticello.

Concurrently, institutions of higher education, both public and private, were developing in communities around the state.

The research mission statements for public universities in Arkansas illustrate the variety in emphasis placed on research in the late 1980s. The following table contains the statements:

Arkansas State University - Jonesboro.	While teaching is the primary focus for faculty members at ASU, research, particularly applied research, is also an important responsibility.
Arkansas Tech University - Russellville	Teaching is the primary focus for faculty members at ATU. Within the available time and resources, faculty members also are encouraged to participate in research and other scholarly activities.
Henderson State University - Arkadelphia	Teaching is the primary focus for faculty members at HSU. Within the available time and resources, faculty members are also encouraged to participate in research and other scholarly activities.
Southern Arkansas University - Magnolia	Teaching is the primary focus for faculty members at SAUM. Within the available time and resources, faculty are encouraged to participate professionally in appropriate research and other scholarly activities.
University of Arkansas - Fayetteville	Conducting basic and applied research is a significant responsibility of faculty members at UAF, along with teaching and public service activities. The research program is designed to advance the frontiers of knowledge and to apply that knowledge to improve the standard of living and quality of life of people in Arkansas, the nation, and the world. The research program also plays an important role in graduate education by helping UAF graduate students appreciate and know how to implement research.

University of Arkansas, Division of Agriculture	The University of Arkansas Division of Agriculture is a statewide, multi-unit research and extension organization for agriculture, forestry, home economics, community development, and youth training.
University of Arkansas at Little Rock - Little Rock	While teaching is the primary focus for most faculty members at UALR, research is of growing importance. Much of the research is applied research related to the institution's professionally oriented graduate programs and extensive public service mission, although faculty members associated with the Graduate Institute of Technology also have special responsibility for basic research.
University of Arkansas for Medical Sciences - Little Rock	UAMS is a principal biological research center and has the major responsibility in Arkansas for research in the medical sciences. Applied and basic research in these disciplines is an important expectation of faculty members, along with teaching and public service duties.
University of Arkansas at Monticello	Teaching is the primary focus for faculty members at UAM. Within the available time and resources, faculty members also are encouraged to participate in research and other scholarly activities. A strong emphasis is placed on applied research, and UAM cooperates with the Department of Agriculture and other campuses within the University of Arkansas to maintain a strong, cooperative program of basic research and development in agriculture and forestry.
University of Arkansas at Pine Bluff	Teaching is the primary focus for faculty members at UAPB. Within the available time and resources, faculty members also are encouraged to participate in research and other scholarly activities in addition to their teaching responsibilities. Faculty members participate in research in the arts and sciences, as well as cooperative projects with faculty from other institutions.
University of Central Arkansas - Conway	Teaching is the primary focus for faculty members at UCA. Within the available time and resources, faculty members are also encouraged to participate in research and other scholarly activities.
Source: Arkansas Higher Education Plan: 1989-1994, Arkansas Department of Higher Education.	

Although R&D activity varies on these campuses, each needs to be considered when designing a strategic plan for the state because each contributes to the scholarly capacity.

The federal government added to the research capabilities of Arkansas in the early 1970s by converting the former biological weapons production facility at the U.S. Army Pine Bluff Arsenal into the Food and Drug Administration's National Center for Toxicological Research (NCTR). This facility is located in Jefferson, Arkansas.

In 1979, the National Science Foundation (NSF) requested that seven states write proposals to compete for funds under a new program called EPSCoR, the Experimental Program to Stimulate Competitive Research. NSF had found that a few states received the majority of NSF funds, while there was a group of states that received an order of magnitude less in NSF funding *per capita* than the national average. Arkansas was one of those seven states. The basic EPSCoR concept was to fund

programs that would overcome the barriers to research in these states. According to NSF, one of those barriers was a lack of state financial commitment. Therefore, all EPSCoR proposals require a substantial dollar-for-dollar state match.

The first EPSCoR Committee in Arkansas was formed as an *ad hoc* group in 1979. It immediately surveyed all scientists in the state to determine active research interests and barriers to conducting research. Of the 1200 scientists identified by the Committee, approximately 900 expressed an interest in doing research. Of those 900, more than 500 returned a detailed questionnaire on research barriers. The six most frequently identified barriers were:

1. Inadequate release time;
2. Lack of "state of the art" equipment;
3. Lack of technical support personnel for the laboratory;
4. Lack of support from department leaders and higher administration;
5. Lack of technical services for research (glass blowing, repairs, etc.); and
6. Lack of laboratory space.

Arkansas was one of the five original NSF-funded EPSCoR states and received $3,000,000 in federal support during 1980-85. These funds were used to support research projects of individual investigators. State matching monies were requested by Governor Bill Clinton, and they were appropriated but never funded; therefore, the responsibility for making the match was assumed by the participating universities.

During the first years of the EPSCoR award, the EPSCoR Committee became concerned about "life after EPSCoR." In 1982, the Arkansas Legislative Council formed a task force with former Congressman Ray Thornton, then president of Arkansas State University, as chair. The task force recommended the creation of an economic development-oriented R&D organization. As a result of this recommendation, the General Assembly in 1983 created the Arkansas Science & Technology Authority (ASTA) and charged it with increasing the R&D activity of the state. In 1985, as part of Governor Clinton's major economic development initiative, the General Assembly established at the Authority the Basic Research Grant Program, which is the direct descendant of the 1980-85 EPSCoR program. The original EPSCoR Committee became the Authority's Science Advisory Committee and implemented the Basic Research Grant Program.

During the first decade of its existence, the Authority promoted Arkansas' R&D climate by:

- awarding 101 Basic Research Grants, totaling $3,384,664;
- awarding 35 Applied Research Grants, totaling $850,701;
- placing $1,500,500 in Seed Capital Investments that created 264 jobs;
- establishing 7 Business Incubators around the state.

The EPSCoR concept subsequently was adopted by other national funding agencies. Arkansas has received EPSCoR-type funding from the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the Department of Defense (DOD), the Environmental Protection Agency (EPA), and the National Institutes of Health (NIH). More important than the money, these EPSCoR programs convinced Arkansans that we could enhance our research productivity more efficiently by working together rather than apart. ASTA has promoted the EPSCoR program by:

- providing $1,702,000 in matching moneys for the Phase II and Phase III EPSCoR programs;

- providing a $300,000 match for the NASA Space Consortium Grant that was awarded to a group of seven colleges and universities in the State;
- furnishing office space for the EPSCoR program manager since 1987; and
- providing $750,000 for Department of Energy/EPSCoR Traineeships.

In the late 1980s, NSF initiated Phase II of EPSCoR, a two-year effort aimed at building research centers. The Arkansas response to this opportunity was the statutory establishment in 1989 of the Centers for Applied Technology Program at the Science & Technology Authority. Governor Clinton requested an appropriation of state matching funds and released $1,120,000 to match $1.2 million from NSF. These funds supported three centers: the Center for Protein Dynamics at UAF, the Arkansas Neurobiology Research Center at UAMS, and the Center for Cellular and Molecular Studies on Biological Aging at UAMS.

Phase II EPSCoR matured into Phase III and was a three-year, $3 million continuation of the three Centers established in Phase II. Governor Clinton was unable (for strictly financial reasons) to release any matching funds in the first year, and this $1,000,000 obligation once again fell to the Authority and the participating universities. Governor Tucker released $900,000 in state funds and the universities matched $1.1 million for years two and three.

In September 1993, the Arkansas Institute reported that Arkansas still was not receiving its fair share of federal research dollars. In 1990, Arkansas was 43rd in the amount of federal R&D funding. The report further indicated that this was related to the fact that the state had the lowest number of Ph.D. scientists and engineers *per capita.* In addition, the report noted the lack of federal support for private sector R&D in Arkansas.[1]

However, the Arkansas Institute report did indicate that Arkansas was successful at obtaining federal funding when a cooperative effort was used to encourage R&D. The EPSCoR program, the Poultry Science Center, the High Density Electronics Center (HiDEC), and the Mack Blackwell Transportation Center were mentioned specifically. According to the Institute, a major shortcoming of Arkansas was the lack of a comprehensive statewide plan for R&D. At approximately the same time, NSF also exerted pressure on Arkansas to develop a statewide R&D plan, which would be required as part of its fourth round EPSCoR proposal.

The Arkansas EPSCoR Committee was made a standing committee of ASTA on November 19, 1994. An ASTA Vice President for EPSCoR (funded by grant dollars) was added to the staff on December 1, 1994.

The state submitted a proposal for a Phase IV EPSCoR funding in November 1994, and Governor Tucker requested matching funds for this proposal from the 1995 legislative session.

[1]*Richard A. Huddleston (1993) Federal R&D Expenditures in Arkansas: Today's Realities, Tomorrow's Options, Report R-1 of the Arkansas Institute*

APPENDIX C

REPORTS OF THE FOUR WORKING SUBGROUPS

HUMAN RESOURCES

This group was charged with recommending changes to increase the technology base of the average Arkansan and increase the number of scientists and engineers produced by Arkansas institutions of higher education. The following strategic initiatives were drawn from other State plans and used as focal points for the Human Resources Working Subgroup:

1. Reform and revitalize public education;
2. Eliminate adult illiteracy;
3. Rationalize systems of higher education;
4. Strengthen business-driven technical schools; and
5. Improve human resource development, health, and preparedness.

The following goals were designed with these initiatives in mind:

1. Arkansas industry and institutions of higher education should recruit individuals who have a proven record of obtaining extramural support for their research.
2. The technical college system of Arkansas should develop close ties with area industries so that they can develop training programs that better meet the needs of those industries.
3. The state should solidify support for efforts that (a) improve teacher preparation in science and mathematics; (b) encourage high school and undergraduate students to pursue research activities; and (c) increase the scientific and technical literacy of the citizenry. Educational programs need to stimulate student interest in science and technology. Special attention should be directed toward strengthening the math/science preparation of women and African-American students.
4. Arkansas must educate more scientists and engineers. Colleges and universities should be encouraged to develop and implement plans to attract more students into these fields. Each institution should develop its own strengths in math/science education.
5. Arkansas must strengthen its research efforts in the sciences. Faculty must be encouraged to participate in research programs, particularly those that are of an "applied" nature and in tune with the needs of industry.

Several specific action items were recommended to address these goals. State initiatives should:

1. Strengthen minority participation at all levels of education, including increased recruitment and retention of minority faculty;
2. Develop an increased consciousness of human resources development components in all R&D projects;

3. Develop the NSF Rural Systemic Initiative Program with Louisiana and Mississippi;
4. Develop in-service teacher training programs that enhance the understanding of science and technology;
5. Increase the use of technology in educational programs at all levels;
6. Increase research opportunities for high school and undergraduate students;
7. Seek additional funding for graduate students;
8. Encourage collaborative efforts in research and education among all educational institutions in the state;
9. Increase private sector input into research and education at all levels;
10. Encourage the recruitment and retention of productive research scientists at all institutions of higher education; and
11. Increase science literacy in the state.

POLICY AND INFRASTRUCTURE

The Policy/Infrastructure Working Group was charged with developing a strategy to improve the climate for R&D in Arkansas. In order to develop such a plan, the Working Group first attempted to determine why Arkansas received a disproportionately low amount of federal support for R&D. Several reasons were identified. They were:

1. Arkansas has the fewest number of scientists per capita with very few in the private sectors.
2. Arkansas has the lowest percentage of graduate students in math, engineering and science.
3. Arkansas lacks high technology industries.

The Working Group also identified the state's strengths and weaknesses. The strengths included:

1. Excellence in existing research programs at UAF, UAMS, NCTR, the Pine Bluff Arsenal, ASTA, and the 33 other institutions involved in research;
2. The quality of the environment; and
3. The entrepreneurial spirit of the people.

Weaknesses included:

1. The absence of tax incentives, such as loss write-off allowances for R&D activities;
2. Financing issues such as the usury law and lack of venture capital;
3. The absence of references to R & D activities in current incentive and tax legislation;
4. The relative lack of high tech industries;
5. The relatively low level of math and science skills in the labor force;
6. The lack of an established concentration of scientists and engineers;
7. The small number of incubator facilities offered by the state;
8. Lack of accessibility to major transportation services;
9. Lack of state commitment, especially long-term commitment, to R&D with strong industry support; and
10. Lack of active local development authorities.

To improve the climate for R&D, the Working Group proposed that the state should:

1. Develop a technology extension service program for the state. In 1993, Governor Jim Guy Tucker appointed a task force composed primarily of technology and business service providers. This "Coordinating Council" has been working to develop and implement an "Arkansas' Manufacturing Extension Network" that will provide comprehensive technical and management assistance with statewide capabilities. Services will include: (a) a "1-800" access number to the network's services through a Network Project Office and an Information Technology Office; (2) five regional, strategically located field offices in the state that are staffed with field engineers; (3) integrated field teams composed of individuals whose expertise is needed for the delivery of services; and (4) a "benchmarking or best practices program" that offers regional and sector-specific demonstrations and workshops.
2. Strengthen computer networking within the state.
3. Develop shared instrumentation resources.
4. Develop focus groups that promote interactions among institutions involved in R&D.
5. Provide matching funds for major R&D grants and contracts.
6. Reexamine the utility of possible incentives to promote R&D, such as enterprise zones, investment tax credits, loss write-off legislation for R&D, sales tax exemptions on R&D, assessment practices for R&D facilities, and other tax exemptions.
7. Encourage the use of costs/benefit analysis for future investment of state funds.
8. Provide incentives for existing companies to move into R&D.
9. Increase the number of doctoral graduates in science and technology by increasing graduate stipend levels, providing more research fellowships, and offering degree programs that are interdisciplinary.
10. Encourage more students, especially women and minorities, to go into math, sciences, and engineering by providing tuition waivers, forgivable loans, etc.
11. Promote technology-transfer by actions such as establishing a liberal patent policy for state universities, developing a patent/copyright assistance program (i.e. Act 707), and encouraging university and college faculty to spin-off into private business and/or manufacturing.
12. Give institutions the ability to create provisional positions as needed for grants and contracts.
13. Create a state level fund for matching major research grants. The state must establish priorities for the use of these funds, possibly EPSCoR programs and other "centers" proposals.
14. Replace the current 12-year depreciation schedule with a five-year schedule for research equipment and an 18-month schedule for computers.
15. Revise Department of Higher Education funding formulas to recognize the increased maintenance cost of laboratories as compared to classrooms, and to include R&D components as criteria for productivity.
16. Create an infrastructure to assist in grant procurement and administration.
17. Recruit National Academy of Science researchers.

18. Promote the development of research parks by (a) providing planning and leadership from the community; (b) assisting in the establishment of partnerships among industry, academic institutions and government labs; and (c) identifying low-cost land with adequate utilities and accessibility.

Item 18 was reported by SILO in its May 1985, newsletter under the title of *The Luring of High Tech.* Similar needs were reported previously by AIDC.

R&D CAPACITY

INTRODUCTION

The R&D Capacity Working Group was charged with examining ongoing R&D activity in Arkansas, identifying R&D strengths and needs, and recommending areas in which Arkansas should concentrate its efforts. It should be noted that this report emphasizes those R&D activities that are directly related to economic advancement. In many cases, these activities are primarily scientific and technological in character. However, this emphasis on economic value, science and technology should not undermine the importance of widespread research and scholarly activity in the humanities and social and behavioral sciences. An improved quality of education, a technologically literate citizenry, and enhanced decision-making capacity in government depends on a widespread and healthy sense of inquiry, which is not always tied to the immediate creation of economic value.

METHODOLOGY

The R&D Capacity Working Group used an extensive survey to determine R&D strengths and needs in Arkansas. The survey was conducted by the Arkansas Institute (see Appendix D) and directed toward three research sectors: (1) Arkansas industries; (2) research-active departments affiliated with state colleges; and universities and (3) institutes and centers affiliated with Arkansas colleges and universities;.

RESULTS OF THE SURVEY

Survey results indicated that Arkansas' R&D strengths are in the areas of agriculture, biotechnology, health-related fields, and electronics. Together these areas represented 82% of the research expenditures. However, in spite of these apparently strong R&D areas, Arkansas' R&D capacity remained extremely low. Available data indicated that R&D consistently represented less than 1% of Arkansas' gross state product (GSP). In contrast, R&D consumes 5-7% of the GSP in leading states such as Massachusetts and Maryland.

Results also suggested that there was little interaction between industrial needs and university research. Many university programs were driven internally by funding source or investigator preference. Only about 3% of the research performed by research active departments and about 7% of that conducted by university centers and institutes was initiated by or for in-state businesses.

Survey responses also identified numerous obstacles that prevented companies from meeting their R&D needs. The top five were related directly or indirectly to costs. These were:

1. Not enough money for R&D;
2. Lack of in-house R&D expertise;
3. High cost/ benefit ratio of R&D;
4. Inability to estimate the costs or benefits of R&D; and
5. Lack of in-house capacity to assimilate or use the results of R&D.

In addition, the survey confirmed other reports by showing that 91% of Arkansas industry invested 6% or less of its expenditures in R&D. No R&D expenditures were reported by 43%. However, most respondents indicated a need for additional R&D.

RECOMMENDATIONS

The Working Group proposed that future advances in Arkansas R&D could be promoted best by focusing state efforts and funding on certain areas of interest. These areas were based in part on existing strengths in R&D and in part on the state's economic climate. The Working Group also stated that future development in the proposed areas of emphasis often would require efforts beyond those involved in technological and bench-oriented research. In particular, meaningful development often would require research in public policy, ethical considerations, and social and behavioral sciences. A multi-disciplinary approach of this type was felt to be essential for each of the target areas.

The areas identified for R&D priority were:

- Advanced Materials
- Agriculture, Food and Life Sciences
- Biotechnology and Bioengineering
- Environment
- Manufacturing Systems
- Transportation and Logistics.

Each of these areas is discussed briefly in the sections that follow.

Advanced Materials. Materials science is the study of the properties and applications of materials used in construction or manufacturing processes. Areas of particular importance and potential for economic development include structural materials, adhesives and coatings, biocompatible materials, and recycling. The fundamental sciences include macromolecular chemistry, polymer science, thin layer physics, ceramics engineering, and the biological sciences as related to biotechnology.

Agriculture, Food and Life Sciences. Agriculture, food, and life sciences are essential for a comprehensive R&D strategy in the state of Arkansas. Critical issues include (1) economic development, especially in the food and fiber industries; (2) environmental quality and conservation; and (3) advanced technologies. More efficient and effective technologies for the production, processing and marketing of food and fiber are required to assure the availability of safe and nutritious food products. With environmental issues at the forefront of public concern, there should be a commitment to improving technologies for the conservation of clean, safe water. The effects of crop, forestry, and livestock production systems on the environment are critical and must be evaluated. Also, there should be a focus on enhancing and creating technologies that will increase efficiency and provide new and improved products that will add to commerce and industry and result in improved agricultural practices. Focus areas should act to create new and more efficient databases, advance communications technology, enhance research in agricultural biotechnology and advance technologies for bioremediation.

Biotechnology and Bioengineering. Biotechnology is the application of molecular biology, living organisms, and biological products and processes to industrial, agricultural, and environmental problems, while bioengineering can be broadly defined as the application of engineering methods and instrumentation to biological or biomedical problems. Underlying fundamental sciences include biochemistry, food science and nutrition, molecular and cellular biology, neuroscience, immunology and microbiology, pathology, pharmacology, pharmaceutical sciences, toxicology, physiology and biophysics, sensor technology, electronic engineering, and computer and information sciences.

Environmental. Environmental research and development is compatible with the perception of Arkansas as the natural state. Research into advanced waste disposal technologies would benefit the citizens by ensuring a healthier environment and by providing economic stimulus for a recognized growth industry. Areas for particular focus should include pollution minimization, pollution remediation, and environmental cleanup technologies.

Manufacturing Systems. Arkansas has a number of compelling reasons to be involved in R&D related to manufacturing technologies. First, competition from both foreign and domestic sources will require more cost effective manufacturing methods. Second, industries are becoming dependent on innovative and state-of-the-art manufacturing processes that must be operated by trained and skilled workers. Third, the state of Arkansas currently possesses some R&D capacity in this area.

Transportation and Logistics. Arkansas is well positioned to become a leader in transportation and logistics research. The headquarters of three major motor carriers with annual revenues totaling more than $2 billion are based in Arkansas. In addition, more than 70,000 Arkansans earn in excess of $1.9 billion annually in the trucking industry. The industry provides more than $122 million each year to the state in highway taxes. Relative to other businesses, the industry is environmentally friendly, and pay levels are well above average. Considering its prominence in the state, R&D in the area of transportation and logistics is justified to preserve the industry's impact on the state's economy.

In addition to the six areas discussed above, there are other important "non-industrial" areas of R&D that obviously create economic value but have not been addressed directly in this report. Examples include planning, rural transportation and communication systems, health and human services research, health care delivery, and creation of "human capital" through training programs.

COMMUNICATIONS

The Communications Working Group was charged with developing a plan to increase communications throughout all groups and areas of Arkansas. Resulting actions should bring the information superhighway to Arkansas, promote distance education by compressed video and other technologies, develop lines of communication among all R&D participants in Arkansas, and promote technology transfer.

The Working Group recommended that the state should act to:

1. Facilitate communication linkages among businesses, research facilities and university faculty;
2. Encourage collaborations among campuses;
3. Link state and federal resources and opportunities;
4. Establish a method of coordinating communications efforts (this would be best accomplished by creating a communications coordinator position, preferably a position with access to the Governor); and
5. Develop an R&D database that includes industry data. This database should identify areas of expertise, areas of growth, and areas of interest. All colleges and universities in the state should participate. Such a data base would (a) lead to interactions among facilities and investigators; (2) make it possible for companies to search for assistance in R&D; and (3) provide a source that the state can use to analyze growth and identify special areas of interest.

APPENDIX D

RESULTS OF THE EXTERNAL SURVEYS

The R&D Capacity Working Group used an extensive survey to determine R&D strengths and needs in Arkansas. This survey was conducted by Richard Huddleston of the Arkansas Institute. The following is a summary of the raw data obtained in response to this survey.

INDUSTRIAL RESPONSES

The response rate from Arkansas industries was 14%; 294 usable responses were obtained from the 2105 surveys mailed. Table 1 shows the percent of total expenditures spent for R&D in these companies.

Table 1

Expenditures	% of Respondents
Zero	43.3
Up to 3%	36.4
4 to 6%	11.7
7 to 10%	5.2
More than 10%	3.4

Table 2 shows where this money was spent.

Table 2

Use of R&D Funds	% of Total
In-House at a Company in Arkansas	63.9
In-House at a Facility Out-of-State	20.4
Joint Research with an In-State University	2.0
Joint Research with an Out-of-State University	0.5
R&D Partnership with an In-State Company	2.1
R&D Partnership with an Out-of-State Company	2.3
Contracted to In-State University Scientists	0.7
Contracted to Out-of-State University Scientists	0.5
Contracted to In-State Companies	1.2
Contracted to Out-of-State Companies	3.0

The companies reported that their need for R&D had increased 52.4% during the previous five years, and they expected it to increase 57.6% during the next five years. The companies indicated that 42.5% of their R&D needs were met five years ago, 46.2% today, and they expected 50.1% of their needs to be met in five years.

Arkansas companies identified the following obstacles to R&D. These items are listed in order of most reported to least reported:

1. Not enough money for R&D
2. Lack of in-house R&D expertise
3. Cost of R&D would outweigh potential economic benefits
4. Unable to estimate the benefits of R&D
5. Lack of in-house expertise to assimilate or use the results of R&D
6. Unable to identify specific R&D needs
7. Government regulations concerning the environment, health, or safety
8. Could not find competent outside scientists who were willing or able to assist with the necessary R&D
9. No urgency to conduct R&D because it was satisfied with the current situation
10. Would be unable to reap economic benefits because of current patent laws and the inability to prevent dissemination of R&D results

11. Could not complete R&D in the time needed
12. Had bad previous experiences in attempts at R&D
13. Could not catch up with competitors
14. Federal or state anti-trust laws blocking joint industry projects

The following is a list of projects reported as ongoing by Arkansas industries. They are grouped by SIC names. The right-hand column shows the number of projects reported.

Table 3

Industry	Number
Industrial Machinery and Equipment	39
Food and Kindred Products	36
Fabricated Metal Products	34
Lumber and Wood Products	25
Rubber and Miscellaneous Plastic Products	25
Chemical and Allied Products	19
Stone, Clay, and Glass Products	15
Electronic and Other Electric Equipment	14
Primary Metal Industries	12
Transportation Equipment	10
Paper and Allied Products	9
Instruments and Related Products	7
Engineering and Management Services	6
Electric, Gas, and Sanitary Services	4
Textile Mill Products	3
Petroleum and Coal Products	3
Agricultural Production (Crops)	2
Transportation Services	2

Reported industrial R&D needs are listed below in the same manner as above for ongoing projects.

Table 4

Industry	Number
Food and Kindred Products	18
Fabricated Metal Products	18
Industrial Machinery and Equipment	17
Chemical and Allied Products	11
Rubber and Miscellaneous Plastic Products	9
Stone, Clay, and Glass Products	9
Primary Metal Industries	8
Lumber and Wood Products	7
Electronic and Other Electric Equipment	7
Paper and Allied Products	6
Transportation Equipment	5
Electric, Gas, and Sanitary Services	5
Engineering and Management Services	3
Petroleum and Coal Products	2
Transportation Services	2
Textile Mill Products	1

RESPONSES FROM COLLEGE AND UNIVERSITY RESEARCH ACTIVE DEPARTMENTS

Responses were requested from the research officers of all Arkansas colleges and universities. Fifty-two departmental responses were received. Table 5 lists the reporting institutions and the number of departments described from each.

Table 5

Institution	Number of Departments
UAF	20
UAMS	15
UALR	13
ASU	1
UAF Law School	1
UAPB	1
unknown	1

The departments can be grouped into these topic areas:

Agricultural and Wildlife

1. National Center for Agricultural Law Research and Information
2. Entomology
3. Plant Pathology
4. Agricultural, Economic, and Rural Sociology
5. Horticulture

Biotechnology and Life Sciences

1. Biopharmaceutical Sciences
2. Pharmaceutics
3. Pharmacy Practice
4. Radiology
5. Physiology and Biophysics
6. Anatomy
7. Urology
8. Center of Osteoporosis and Metabolic Bone Disease
9. Pharmacology and Toxicology

10. Audiology and Speech Pathology
11. Psychiatry
12. Dietetics and Nutrition
13. Family and Community Medicine
14. Health Services Administration
15. Emergency Medicine
16. OB/GYN

Business-Related
1. Accounting
2. Management

Education
1. School of Education
2. Vocational and Adult Education
3. Educational Leadership, Counseling and Foundations
4. Rehabilitative Education and Research

Engineering and Electronics
1. Chemical Engineering
2. Electronics and Instrumentation
3. Civil Engineering

Fine Arts
1. Foreign Languages
2. Art
3. Music
4. Theater
5. Radio, Television and Film

Liberal Arts
1. Political Science
2. History
3. Anthropology
4. English
5. Journalism
6. Sociology

Mathematics and Physical Sciences
1. Earth Science
2. Mathematical Sciences
3. Computer and Information Science

Transportation and Communication
1. Marketing and Transportation
2. Speech Communication

Miscellaneous
1. Social Work

It should be noted that some of the most active research departments at UAF and UAMS did not respond (e.g. Chemistry & Biochemistry, Physics, Biological Sciences, Biochemistry and Molecular Biology).

The average annual departmental budget was $1,293,892; the median value was $625,000. The percentage of the departments' budgets spent on R&D was reported to average 34.9 with a median value of 37.5%.

Twenty-seven of the departments expected to increase the size of their research staffs during the next five years. Twenty-three expected no growth. The average expected increase was 25.3% with a median response of 20%.

The departments reported an average of 3.7 faculty as nationally competitive. The median response was three.

RESPONSES FROM COLLEGE AND UNIVERSITY CENTERS AND INSTITUTES

Responses were requested from the research officers of all Arkansas colleges and universities. Thirty-six were received.

Table 6 lists the reporting institutions and the number of centers and institutes described for each.

Table 6

Institution	Number of Centers & Institutes
UAF	15
UAMS	8
UALR	4
ASU	2
UCA	3
UAPB	1
ATU	1
Henderson	1
Hendrix	1

The centers and institutes can be grouped into these areas:

Aeronautics and Surface Transportation
1. Mack-Blackwell Rural Transportation Center

Agricultural and Wildlife
1. Center of Excellence for Poultry Science
2. Aquaculture/Fisheries Center of Excellence

Biotechnology and Life Sciences
1. Arkansas Biotechnology Center
2. Arkansas Cancer Research Center
3. Center for Protein Dynamics
4. Arkansas Center for Eye Research
5. Biomedical Biotechnology Center
6. University of Arkansas Speech and Hearing Clinic

Economics

1. Economic Development Center
2. Bessie Moore Center for Economic Education
3. Arkansas Institute for Economic Advancement
4. Office of Business Research
5. Small Business Advancement National Center
6. Arkansas Research and Training Center on Vocational Rehabilitation
7. Small Business Institute

Education

1. Center for Excellence in Education
2. Center for Research and Teaching
3. Central Regional Partnership/Arkansas Statewide Systemic Initiative
4. Center for Academic Excellence

Electronics

1. High Density Electronics Center
2. Engineering Research Center

Energy

1. Center for Energy Studies

Environment

1. Arkansas Water Resources Center
2. Arkansas Cooperative Research Unit

Health and Social

1. Center for Outcomes Research and Effectiveness
2. Center for Alcoholism and Drug Abuse
3. Center for Mental Health Care Research
4. College of Nursing Research Center
5. Mid-South Center for Social Work Education, Research, and Training
6. Criminal Justice Institute
7. Center for Applied Research and Evaluation

Technology and Manufacturing

1. Center for Advanced Spatial Technologies/National Center for Resource Innovation

Miscellaneous

1. Walton Arts Center
2. Hendrix-Murphy Foundation Programs in Literature and Language

The average annual budget reported for a center or institute was $1,808,129; the median value was $900,000. The percentage of the centers' and institutes' budgets spent on R&D was reported to average 62.6 with a median value of 68.3%.

Twenty-two of the centers and institutes expected to increase the size of their research staffs during the next five years. Fourteen did not expect an increase. The average expected increase was reported as 85% with a median response of 40%.

The centers and institutes reported an average of 9.4 faculty as nationally competitive. The median response was 2.5.